

## **Phase Three: Data Collection and Analysis**

### **Data Analysis Report**

# **Total Maximum Daily Load for Pathogens in Soquel Lagoon, Santa Cruz County, California**

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Central Coast Regional Water Quality Control Board  
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## 1. PROJECT DEFINITION

### 1.1. Beneficial Uses

The California Regional Water Quality Control Board (Regional Board) is responsible for protecting water resources from pollution and nuisance that may occur as a result of waste discharges. The Regional Board determines beneficial uses (in the *Water Quality Control Plan* (Basin Plan)) that need protection. The Regional Board adopted water quality objectives that are necessary to protect the beneficial water uses in the Basin Plan.

Soquel Lagoon beneficial uses cited in the Basin Plan are: Contact and Non-Contact Recreation (REC-1 and REC-2); Wildlife Habitat (WILD); Cold Freshwater Habitat (COLD); Migration of Aquatic Organisms (MIGR); Spawning, Reproduction, and/or Early Development (SPWN); Preservation of Biological Habitats of Special Significance (BIOL); Rare, Threatened, or Endangered Species (RARE); Estuarine Habitat (EST); and Commercial and Sport Fishing (COMM).

### 1.2. Problem Statement

Soquel Lagoon fecal coliform exceeds the REC-1 (water contact recreation) water quality objectives. Regional Board staff utilized Soquel Lagoon water quality data collected by the Santa Cruz County Environmental Health Services to determine this objective exceedence.

## 2. NUMERIC TARGET

The most stringent water quality objective applies to the water contact recreation beneficial use. The Basin Plan contains the following REC-1 bacteria objective:

“Fecal coliform concentration, based on a minimum of not less than five samples for any 30-day period, shall not exceed a log mean of 200/100 ml, nor shall more than ten percent of total samples during any 30-day period exceed 400/100 ml.”

Often, available datasets do not contain five samples in a 30-day period, so the portion of the objective that is evaluated is that “no more than ten percent of total samples during any 30-day period exceed 400 / 100 mL.” One can note that, in instances where fewer than five samples were collected in 30 days, the “ten percent” threshold is exceeded if any one sample exceeds 400 / 100 mL.

**Table 1. Numeric Targets for Soquel Lagoon**

<b>Fecal Coliform</b>	
<b>Geometric Mean</b>	<b>Maximum</b>
200 MPN/100 mL <sup>a</sup>	400 MPN/100 mL <sup>b</sup>

<sup>a</sup> Based on not less than five samples for any 30-day period<sup>b</sup> No more than 10% of total samples during any 30-day period

### 3. DATA ANALYSIS

Santa Cruz County sampling activities for Soquel Lagoon are shown in the Table below.

**Table 2. Santa Cruz County Environmental Health Services Sampling Activity Since January 1, 2000**

<b>Station</b>	<b>Number of Samples</b>	<b>Frequency</b>	<b>Period of Record</b>
Soquel Lagoon at Flume Outlet	355	weekly	1/5/2000-3/22/2005

Figure 1 below shows monthly Soquel Lagoon fecal coliform concentrations at the Flume Outlet from 1/5/2000 to 2/22/2005. The graph displays the REC-1 geometric mean standard. Concentration ranges, the range of concentrations within the 25<sup>th</sup> -75<sup>th</sup> percentile range, the mean concentration, and the median concentration are shown. Mean fecal coliform concentrations exceed water quality standards in January, March, and July through December. Median fecal coliform concentrations exceed water quality standards from September through December.

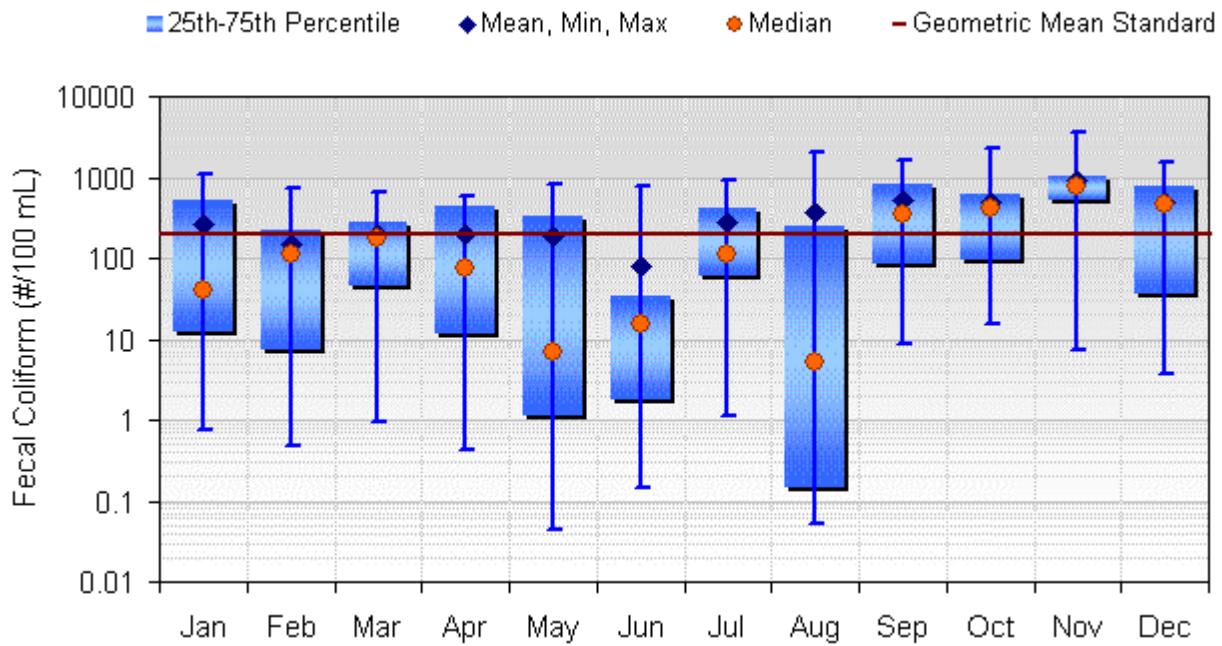
**Figure 1. Soquel Lagoon Fecal Coliform at Flume Outlet (#/100 mL) and Geometric Mean Standard**

Table 3 below provides a summary of the Figure 1. The table summarizes data on a monthly basis and presents the mean, median, minimum, maximum, the 25<sup>th</sup> percent deviation, the 75<sup>th</sup> percent deviation, the number of exceedences of the geometric mean standard versus the sample count (XS: Count), and the percent sample exceedence (XS%) of the geometric standard. Overall, the water quality objective was exceeded 41% of the time with no apparent seasonal trend.

**Table 3. Soquel Lagoon Fecal Coliform at Flume Outlet (#/100 mL) and Exceedence of Water Contract Recreation Geometric Mean Standard**

Summary Statistics ( Data: 1/5/2000 to 3/22/2005)								
Month	Mean	Median	Min	Max	25th	75th	XS: Count	XS%
Jan	261	40	1	1081	12	523	9:21	43%
Feb	153	110	0	733	7	225	7:24	29%
Mar	201	177	1	646	44	277	14:30	47%
Apr	195	76	0	576	12	437	10:27	37%
May	189	7	0	840	1	328	12:40	30%
Jun	82	15	0	790	2	34	4:30	13%
Jul	277	111	1	893	62	419	11:28	39%
Aug	367	5	0	2044	0	244	11:38	29%
Sep	516	346	9	1616	83	841	11:19	58%
Oct	491	424	15	2343	97	619	15:24	63%
Nov	926	780	7	3506	518	1046	19:24	79%
Dec	483	465	4	1544	37	793	14:26	54%
<b>All Data</b>	<b>328</b>	<b>103</b>	<b>0</b>	<b>3506</b>	<b>8</b>	<b>518</b>	<b>137:331</b>	<b>41%</b>

Figure 2 below shows monthly Soquel Lagoon fecal coliform concentrations at the Trestle from 1/5/2000 to 2/22/2005. The graph displays the water contact recreation maximum standard. Concentration ranges, the range of concentrations within the 25<sup>th</sup> - 75<sup>th</sup> percentile range, the mean concentration, and the median concentration are shown. Mean fecal coliform concentrations exceed water quality standards in January, February, April, and June through December. Median fecal coliform concentrations exceed water quality standards in June and September through November.

**Figure 2. Soquel Lagoon Fecal Coliform at Flume Outlet (#/100 mL) and Water Contact Maximum Standard**

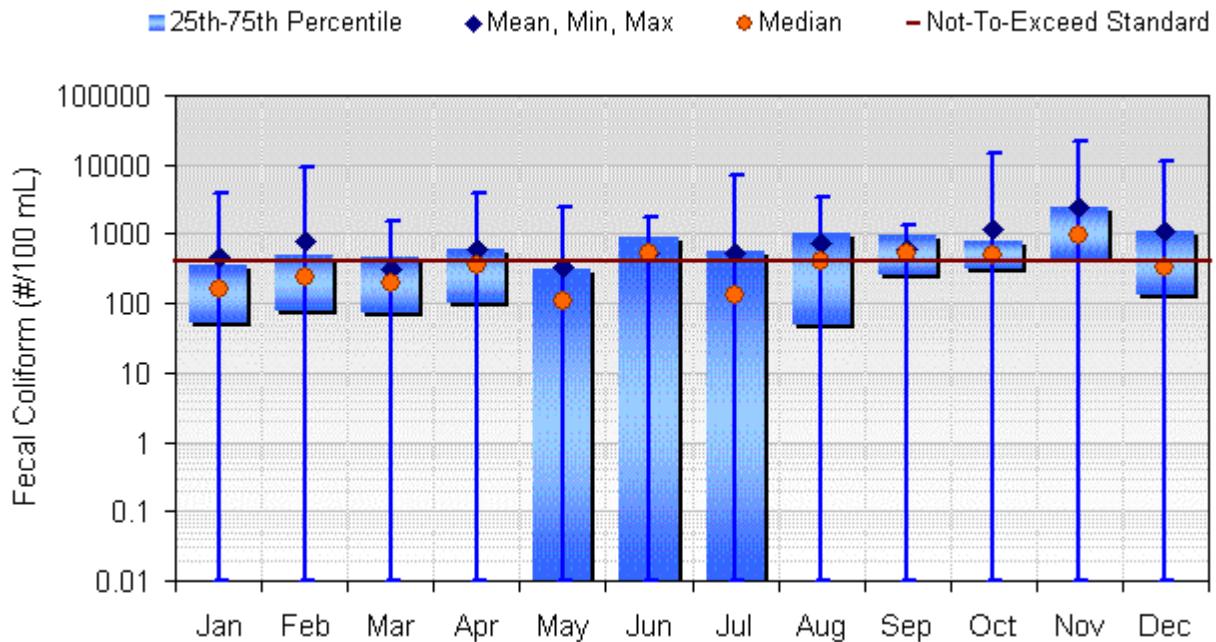


Table 4 below provides a summary of Figure 2. The table analyzes data on a monthly basis and presents the mean, median, minimum, maximum, the 25<sup>th</sup> percent deviation, the 75<sup>th</sup> percent deviation, the number of exceedences of the geometric mean standard versus the sample count (XS: Count), and the percent sample exceedence (XS%) of the water contact recreation beneficial use maximum standard. Overall, the water quality objective was exceeded 43% of the time with no apparent seasonal trend.

**Table 4. Soquel Lagoon Fecal Coliform at Flume Outlet (#/100 mL) and Exceedence of Water Contract Recreation Maximum Standard**

Summary Statistics ( Data: 1/5/2000 to 3/22/2005)								
Month	Mean	Median	Min	Max	25th	75th	XS: Count	XS%
Jan	470	160	0	3970	53	358	6:30	20%
Feb	810	240	0	9100	80	510	10:29	34%
Mar	316	195	0	1550	73	468	11:34	32%
Apr	623	360	0	3840	98	610	15:35	43%
May	344	110	0	2360	0	310	9:37	24%
Jun	537	530	0	1780	0	890	17:29	59%
Jul	543	135	0	7190	0	553	11:34	32%
Aug	761	400	0	3480	50	1010	13:29	45%
Sep	624	515	0	1350	254	980	14:22	64%
Oct	1188	510	0	14850	318	773	16:26	62%
Nov	2397	990	0	21200	435	2368	18:23	78%
Dec	1070	340	0	11370	130	1090	12:27	44%
<b>All Data</b>	<b>754</b>	<b>310</b>	<b>0</b>	<b>21200</b>	<b>65</b>	<b>775</b>	<b>152:355</b>	<b>43%</b>

### 3.1. DNA Fingerprinting

Santa Cruz County collected water column samples at the mouth of Soquel Lagoon. DNA fingerprinting analysis was performed using the ribotyping method and Dr. Mansour Samadpour of the University of Washington completed the analysis. Dr. Samadpour has a library of over 100,000 fingerprints used to identify *E.coli* sources.

DNA fingerprinting results are shown below. The greatest *E.coli* source are birds. Dogs and rodents are also a significant source.

### 3.2. Source Categories

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**Table 5. Microbial Source Identification Results 2003-04**

<b>Location</b>	<b>Load</b>	<b>Soquel Creek @ Mouth</b>
Total Samples		11
Total Isolates		112
Log Mean Fecal Coliform (cfu/100 ml)		701
Bird		53.0%
	Portion of Log Mean Fecal Coliform (cfu/100 ml)	376
Cat		0.9%
	Portion of Log Mean Fecal Coliform (cfu/100 ml)	6
Cow		0.0%
	Portion of Log Mean Fecal Coliform (cfu/100 ml)	0
Dog		13.4%
	Portion of Log Mean Fecal Coliform (cfu/100 ml)	94
Horse		0.0%
	Portion of Log Mean Fecal Coliform (cfu/100 ml)	0
Rodent		13.4%
	Portion of Log Mean Fecal Coliform (cfu/100 ml)	94
Marine Mammal		0.0%
	Portion of Log Mean Fecal Coliform (cfu/100 ml)	0
Unknown		5.4%
	Portion of Log Mean Fecal Coliform (cfu/100 ml)	38
Wildlife		7.1%
	Portion of Log Mean Fecal Coliform (cfu/100 ml)	50
Human		6.3%
	Portion of Log Mean Fecal Coliform (cfu/100 ml)	44

**APPENDIX. SOQUEL LAGOON WATER QUALITY DATA**

<b>Soquel Creek @ Flume Outlet</b>	<b>Fecal Coliform (#/100 mL)</b>
05-Jan-00	60
10-Jan-00	240
27-Jan-00	140
31-Jan-00	880
07-Feb-00	260
14-Feb-00	1250
27-Feb-00	60
08-Mar-00	756
15-Mar-00	190
22-Mar-00	190
29-Mar-00	70
03-Apr-00	76
10-Apr-00	248
12-Apr-00	320
14-Apr-00	1300
15-Apr-00	2900
17-Apr-00	3400
20-Apr-00	380
26-Apr-00	896
02-May-00	124
09-May-00	160
17-May-00	310
23-May-00	120
31-May-00	290
14-Jun-00	600
20-Jun-00	131
27-Jun-00	1780
05-Jul-00	100
11-Jul-00	388
18-Jul-00	110
25-Jul-00	270
02-Aug-00	250
08-Aug-00	110
21-Aug-00	400
24-Aug-00	240
29-Aug-00	350
11-Sep-00	510
18-Sep-00	290
25-Sep-00	530
02-Oct-00	510

<b>Soquel Creek @ Flume Outlet</b>	<b>Fecal Coliform (#/100 mL)</b>
09-Oct-00	1350
16-Oct-00	580
25-Oct-00	340
30-Oct-00	2890
06-Nov-00	450
13-Nov-00	950
22-Nov-00	420
27-Nov-00	3390
05-Dec-00	1130
11-Dec-00	900
18-Dec-00	370
26-Dec-00	280
02-Jan-01	920
08-Jan-01	3970
16-Jan-01	3900
18-Jan-01	20
29-Jan-01	360
05-Feb-01	180
13-Feb-01	240
21-Feb-01	480
26-Feb-01	2380
28-Feb-01	220
06-Mar-01	460
12-Mar-01	320
19-Mar-01	610
27-Mar-01	1550
02-Apr-01	320
03-Apr-01	820
09-Apr-01	390
16-Apr-01	180
23-Apr-01	480
30-Apr-01	620
07-May-01	1610
14-May-01	1750
21-May-01	2360
22-May-01	212
23-May-01	160
24-May-01	160
29-May-01	110
04-Jun-01	410

<b>Soquel Creek @ Flume Outlet</b>	<b>Fecal Coliform (#/100 mL)</b>
13-Jun-01	1050
02-Jul-01	580
09-Jul-01	7190
11-Jul-01	820
17-Jul-01	150
24-Jul-01	530
08-Aug-01	1100
13-Aug-01	50
20-Aug-01	1010
27-Aug-01	710
04-Sep-01	510
10-Sep-01	1020
17-Sep-01	470
24-Sep-01	290
09-Oct-01	510
10-Oct-01	310
15-Oct-01	750
22-Oct-01	750
29-Oct-01	460
30-Oct-01	200
05-Nov-01	1210
13-Nov-01	2910
19-Nov-01	1420
26-Nov-01	1610
03-Dec-01	720
10-Dec-01	310
17-Dec-01	2060
26-Dec-01	90
07-Jan-02	170
14-Jan-02	320
22-Jan-02	60
28-Jan-02	400
04-Feb-02	40
11-Feb-02	60
19-Feb-02	240
25-Feb-02	780
04-Mar-02	80
11-Mar-02	260
19-Mar-02	5
25-Mar-02	80
01-Apr-02	430
08-Apr-02	120
15-Apr-02	190
24-Apr-02	240

<b>Soquel Creek @ Flume Outlet</b>	<b>Fecal Coliform (#/100 mL)</b>
29-Apr-02	920
13-May-02	40
28-May-02	160
03-Jun-02	890
11-Jun-02	260
17-Jun-02	150
25-Jun-02	50
01-Jul-02	110
08-Jul-02	20
16-Jul-02	130
23-Jul-02	130
29-Jul-02	140
05-Aug-02	280
13-Aug-02	400
20-Aug-02	550
27-Aug-02	190
03-Sep-02	110
19-Sep-02	210
24-Sep-02	190
26-Sep-02	240
01-Oct-02	390
08-Oct-02	260
16-Oct-02	1340
21-Oct-02	700
28-Oct-02	180
04-Nov-02	7660
12-Nov-02	290
19-Nov-02	880
26-Nov-02	310
02-Dec-02	340
09-Dec-02	2150
17-Dec-02	1050
23-Dec-02	110
30-Dec-02	210
06-Jan-03	190
22-Jan-03	210
27-Jan-03	350
03-Feb-03	370
10-Feb-03	1460
18-Feb-03	420
24-Feb-03	2660
03-Mar-03	760
17-Mar-03	710
24-Mar-03	930

<b>Soquel Creek @ Flume Outlet</b>	<b>Fecal Coliform (#/100 mL)</b>
01-Apr-03	880
07-Apr-03	450
21-Apr-03	600
29-Apr-03	320
05-May-03	90
12-May-03	40
19-May-03	490
27-May-03	410
02-Jun-03	540
09-Jun-03	640
16-Jun-03	630
23-Jun-03	530
30-Jun-03	570
07-Jul-03	2020
14-Jul-03	500
21-Jul-03	610
28-Jul-03	260
19-Aug-03	670
26-Aug-03	570
02-Sep-03	1300
08-Sep-03	242
15-Sep-03	690
22-Sep-03	1170
29-Sep-03	750
06-Oct-03	830
14-Oct-03	360
20-Oct-03	780
28-Oct-03	480
03-Nov-03	3060
10-Nov-03	990
17-Nov-03	1470
24-Nov-03	870
01-Dec-03	2000
08-Dec-03	320
15-Dec-03	1430
22-Dec-03	550
29-Dec-03	11370
05-Jan-04	200
12-Jan-04	80
20-Jan-04	510
21-Jan-04	80
26-Jan-04	50
02-Feb-04	1500
09-Feb-04	350

<b>Soquel Creek @ Flume Outlet</b>	<b>Fecal Coliform (#/100 mL)</b>
17-Feb-04	510
23-Feb-04	80
01-Mar-04	770
08-Mar-04	540
09-Mar-04	160
22-Mar-04	430
23-Mar-04	310
29-Mar-04	470
05-Apr-04	580
13-Apr-04	530
19-Apr-04	360
26-Apr-04	910
03-May-04	1670
10-May-04	950
17-May-04	590
24-May-04	490
01-Jun-04	670
14-Jun-04	1350
15-Jun-04	1580
16-Jun-04	1160
22-Jun-04	1000
24-Jun-04	1100
28-Jun-04	560
06-Jul-04	760
12-Jul-04	350
19-Jul-04	1720
20-Jul-04	1020
26-Jul-04	940
02-Aug-04	3080
03-Aug-04	3480
09-Aug-04	1070
16-Aug-04	2480
18-Aug-04	2700
23-Aug-04	1440
30-Aug-04	1350
07-Sep-04	1280
14-Sep-04	520
20-Sep-04	1200
21-Sep-04	860
28-Sep-04	1100
04-Oct-04	300
12-Oct-04	680
18-Oct-04	14850
26-Oct-04	21200

Soquel Creek @ Flume Outlet	Fecal Coliform (#/100 mL)
01-Nov-04	300
09-Nov-04	1825
15-Nov-04	3075
23-Nov-04	850
29-Nov-04	800
09-Dec-04	2300
13-Dec-04	260
21-Dec-04	150
27-Dec-04	2900
04-Jan-05	150
10-Jan-05	640
18-Jan-05	40
24-Jan-05	150
01-Feb-05	50
07-Feb-05	140
15-Feb-05	9100
17-Feb-05	240
22-Feb-05	275
23-Feb-05	150
01-Mar-05	200
08-Mar-05	230
10-Mar-05	90
15-Mar-05	140
16-Mar-05	100
21-Mar-05	320
22-Mar-05	3840